Mumbai University

Question Paper

[CBSGS – 75:25 PATTERN]

(APRIL – 2017)

PAPER - II

DIGITAL

SIGNALS AND SYSTEMS

Time: 2 ½ Hours **Total Marks:** 75

N.B.: (1) *All Question are Compulsory.*
(2) *Make Suitable Assumptions Wherever Necessary And State The Assumptions Made.*
(3) *Answer To The Same Question Must Be Written Together.*
(4) *Number To The Right Indicates Marks.*
(5) *Draw Neat Labeled Diagrams Wherever Necessary.*
(6) *Use of Non – Programmable Calculator is allowed.*

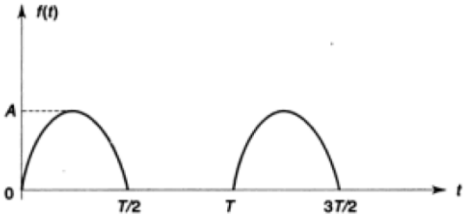
Q.1 ATTEMPT ANY TWO QUESTIONS: (10 MARKS)

(A) State and explain the properties of Unit Impulse Function (t). **(5)**

(B) How are Continuous and Discrete Time Systems classified? Explain. **(5)**

(C) What are Energy and Power Signals? **(5)**
Determine if the following signals are energy signals or power signals or neither:
(i) $x(t) = tu(t)$
(ii) $x(n) = (-0.5)^n u(n)$

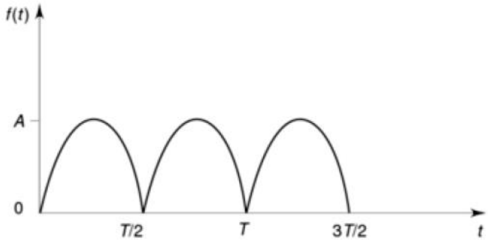
(D) Obtain the Trigonometric Fourier series for the half wave rectified sine wave shown below: **(5)**



Q.2 ATTEMPT ANY TWO QUESTIONS: (10 MARKS)

(A) Find the Laplace Transform of the following functions: **(5)**
(i) $f(t) = \frac{1-e^t}{t}$
(ii) $f(t) = cos^3 3t$

(B) Find the Laplace transform of the full wave rectified output as shown below: **(5)**



(C) Find the inverse Laplace transform of $\left\{\frac{S^2-S-3}{(S+5)(S+4)^2}\right\}$ **(5)**

(D) The unit step of a network is $(1 - e^{-at})$. Determine the impulse response $h(t)$ of the network. **(5)**

Q.3 ATTEMPT ANY TWO QUESTIONS: (10 MARKS)

(A) A system has an impulse response $h(n) = \{1,2,3\}$ and output response $y(n) = \{1,1,2,-1,3\}$. Determine the input sequence $x(n)$. **(5)**

(B) Determine the z-transform for the analog input signal $x(t) = e^{-at}$ applied to a Digital Filter. **(5)**

(C) How is z-transform obtained from Laplace Transform? Derive the z-transform of $f(nT) = cos\ \omega nT$ **(5)**

(D) Define one-sided z-Transform, Two-sided z-Transform and Inverse z-Transform. **(5)**

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Q.4 ATTEMPT ANY TWO QUESTIONS: (10 MARKS)

(A) Explain the Paley – Wiener criteria. **(5)**

(B) Consider a causal and stable LTI system whose input $x(n)$ and output $y(n)$ are related through the second order difference equation. $y(n) \ -\frac{1}{12}y(n-1) - \frac{1}{12}y(n-2) = x(n)$ **(5)**
Determine the step response for the system.

(C) Find the response of the following difference equation **(5)**

$$y(n) - 5y(n-1) + 6y(n-2) = x(n)\ for\ x(n) = u(n)$$

(D) A second order discrete time system is characterised by the difference equation **(5)**

$$y(n) - 0.1y(n-1) - 0.02y(n-2) = 2x(n) - x(n-1)$$

Determine y(n) for $n \ \geq \ 0$ when $x(n) \ = \ u(n)$ and the initial conditions are

$$y(-1) =-10\ and\ y(-2\,) = 5$$

Q.5 ATTEMPT ANY TWO QUESTIONS: (10 MARKS)

(A) Find the 4-point DFT of the sequence $x(n) \ = \ cos\frac{n\pi}{4}$. **(5)**

(B) Compute the circular periodic convolution graphically of the two sequences: **(5)**

$$x(n) = \delta(n) + \delta(n-1) - \delta(n-2) - \delta(n-3)\ and$$
$$h(n) = \delta(n) - \delta(n-2) + \delta(n-4)$$

(C) Determine the cross-correlation values of the two sequences $x(n) = \{1,0,0,1\}$ and $h(n) = \{4,3,2,1\}$. **(5)**

(D) Distinguish between linear convolution and circular convolution. **(5)**

Q.6 ATTEMPT ANY TWO QUESTIONS: (10 MARKS)

(A) Design a digital Chebyshev filter to satisfy the constrains **(5)**

$$0.707 \leq \ \left|H\left(e^{j\omega}\right)\right| \leq 1, \qquad 0 \leq \omega \leq 0.2\pi$$
$$\left|H(e)^{j\omega}\right| \leq 0.1, \qquad 0.5\pi \leq \omega \leq \pi$$

Using bilinear transformation and assuming $T = 1s$.

(B) Design a Finite Impulse Response low pass filter with a cut-off frequency of $1kHz$ and sampling rate of 4kHz with eleven samples using Fourier series. **(5)**

(C) An analog filter has the following system function. Convert this filter into a digital filter using backward difference for the derivative. **(5)**

$$H(s) = \frac{1}{(s+0.1)^2\ +\ 9}$$

(D) Design a digital Chebyshev filter to satisfy the constrains **(5)**

$$0.707 \leq \ \left|H\left(e^{j\omega}\right)\right| \leq 1, \qquad 0 \leq \omega \leq 0.2\pi$$
$$\left|H(e)^{j\omega}\right| \leq 0.1, \qquad 0.5\pi \leq \omega \leq \pi$$

Using bilinear transformation and assuming $T = 1s$.

[TURN OVER]

Q.7 **ATTEMPT ANY THREE QUESTIONS: (15 MARKS)**

(A) Write a short note on Dirichlet's conditions. **(5)**

(B) In the parallel RLC circuit. $\mathrm{I_0} = 5\ \mathrm{A}, \mathrm{L} = 0.2\ \mathrm{H}, \mathrm{C} = 2\ \mathrm{F}$ And $R = 0.5\ \Omega$. Switch S is opened at time $t = 0$. Obtain the complete particular solution for the voltage $v(t)$ across the parallel network. Assume zero current through inductor L and zero voltage across capacitor C before switching. **(5)**

(C) Convolve the sequences $x(n)$ and $h(n)$ where **(5)**

$x(n) = 0, n < 0$
$\quad = a^n, n \geq 0$
$h(n) = 0, n < 0$
$\quad = b^n, n \geq 0$

Specify the answers if **(i)** $a = b$ and **(ii)** $a \neq b$

(D) Find the convolution of the two signals **(5)**

$$x(n) = u(n)\ and\ h(n) = a^n u(n), \mathrm{ROC}: |a| < 1; n \geq 0$$

(E) Find the circular periodic convolution using DFT and IDFT of the two sequences: **(5)**

$$x(n) = \{1,1,2,2)\ and\ h(n) = \{1,2,3,4\}$$

(F) Design an analog BPF to satisfy the following specifications: **(5)**

(i) *3 dB upper and lower cut-off frequencies are 100 Hz and 3.8 kHz*
(ii) *Stop band attenuation of 20 dB at 20 Hz and 8 kHz.*
(iii) *No ripple with both passband and stopband.*
